A new summary measure of inflation expectations

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Highlights of 'A new summary measure of inflation expectations', by George Kapetanios, Becky Maule and Garry Young

- **This note uses the well-known Nelson-Siegel approach to modelling the term structure of interest rates to construct a summary measure of the term structure of inflation expectations.**

- **It uses a diverse set of indicators available at different time horizons**

- **The proposed measure captures the signal contained in UK surveys and provides some information for monetary policymakers.**

A new summary measure of inflation expectations

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1 Introduction

The inflation expectations of households and businesses are important in determining a range of economic outcomes, including wages, saving and investment decisions, and inflation itself. As a result, inflation-targeting central banks continuously monitor risks to inflation expectations in carrying out their inflation-related policy remits. In an inflation targeting regime metrics for such monitoring can be categorised as follows: (i) the level of inflation expectations relative to the target; (ii) uncertainty about inflation; and (iii) the sensitivity of expectations to unexpected economic developments. This note considers the first of these metrics.

Monitoring inflation expectations is complicated by the range of diverse measures that are available at different horizons from a range of different sources. Monetary policymakers, who stress the importance of inflation expectations for monetary policy, have often struggled to extract the signal from the diverse measures available (see discussion in Yellen (2016)). The measure we propose suggests a method for doing this. In this note we outline how a summary measure of the term structure of inflation expectations can be extracted from the various measures that are available.[1] It is based on the

[1]The summary measure discussed in this note has been in continuous use, as a gauge

extension by Diebold and Li (2006), of the well-known Nelson-Siegel (1987) approach to modelling the term structure of interest rates using a dynamic statistical model to estimate the unobserved latent factors underlying the yield curve. We note that related but independent recent work by Aruoba (2016), has considered similar inflation expectation measures developed from surveys of professionals, but with a clear focus on forecasting.

2 The Method

We consider an extended version of the Nelson-Siegel model for the yield curve adapted for the presence of multiple measures of a given maturity of inflation expectations. The model is a state space one. To simplify, suppose that we observe a single data series of inflation expectations $y_t(\tau_j)$ for a set of m different maturities $\tau_1 < ... < \tau_m$ relevant at a given time t, then the extended Nelson-Siegel approach we follow, fits the term structure using the multivariate model

$$y_t(\tau_j) = \mu_j + \lambda_{1j} f_{1t} + \lambda_{2j} f_{2t} + \lambda_{3j} f_{3t} + \epsilon_{jt}$$

for $j = 1, ..., m$, where μ_j is a constant, f_{it} is the i-th factor at time t ($i = 1, 2, 3$), and λ_{ij} is the factor loading for the i-th factor and j-th maturity.

More generally for multiple expectation series, the measurement equation of the model is given by

$$\boldsymbol{y}_t = \boldsymbol{\Lambda} \boldsymbol{f}_t + \boldsymbol{\epsilon}_t$$

where

$$\boldsymbol{y}_t = \begin{pmatrix} \boldsymbol{y}_{t1} \\ ... \\ \boldsymbol{y}_{ti} \\ ... \\ \boldsymbol{y}_{tn} \end{pmatrix}$$

of inflation expectations, in the context of the policy cycle of the Bank of England since late 2013.

$$\boldsymbol{y}_{ti} = \begin{pmatrix} y_{ti}(\tau_{i1}) \\ ... \\ y_{ti}(\tau_{ij}) \\ ... \\ y_{ti}(\tau_{im_i}) \end{pmatrix}$$

where $y_{ti}(\tau_{ij})$ is the observation of the i-th survey ($i = 1, ..., n$) for maturity τ_{ij} at time t. There are five possible maturities in our dataset (4,8,12,16,20 quarters) but not all surveys have all maturities. Each survey has m_i available maturities. Further,

$$\boldsymbol{f}_t = \begin{pmatrix} f_{1t} \\ f_{2t} \\ f_{3t} \end{pmatrix}$$

$$\boldsymbol{\Lambda} = (\boldsymbol{\Lambda}_1, \boldsymbol{\Lambda}_2, \boldsymbol{\Lambda}_3)$$

$$\boldsymbol{\Lambda}_j = \begin{pmatrix} \boldsymbol{\lambda}_{j,m_1} \\ ... \\ \boldsymbol{\lambda}_{j,m_i} \\ ... \\ \boldsymbol{\lambda}_{j,m_n} \end{pmatrix}, \quad j = 1, 2, 3.$$

$\boldsymbol{\lambda}_{1,m_i} = \lambda_{1,i}\boldsymbol{\iota}_{m_i}$ where $\lambda_{1,i}$ is a scalar and $\boldsymbol{\iota}_{m_i}$ is a column vector of ones of dimension m_i.

$$\boldsymbol{\lambda}_{2,m_i} = \begin{pmatrix} \frac{1-\exp(-\tau_{i1}\lambda_{2,i})}{\tau_{i1}\lambda_{2,i}} \\ ... \\ \frac{1-\exp(-\tau_{ij}\lambda_{2,i})}{\tau_{ij}\lambda_{2,i}} \\ ... \\ \frac{1-\exp\left(-\tau_{im_i}\lambda_{2,i}\right)}{\tau_{im_i}\lambda_{2,i}} \end{pmatrix}$$

where $\lambda_{2,i}$ is a scalar.

$$\boldsymbol{\lambda}_{3,m_i} = \begin{pmatrix} \frac{1-\exp(-\tau_{i1}\lambda_{3,i})}{\tau_{i1}\lambda_{3,i}} - \exp(-\tau_{i1}\lambda_{3,i}) \\ ... \\ \frac{1-\exp(-\tau_{ij}\lambda_{3,i})}{\tau_{ij}\lambda_{3,i}} - \exp(-\tau_{ij}\lambda_{3,i}) \\ ... \\ \frac{1-\exp\left(-\tau_{im_i}\lambda_{3,i}\right)}{\tau_{im_i}\lambda_{3,i}} - \exp(-\tau_{im_i}\lambda_{3,i}) \end{pmatrix}$$

where $\lambda_{3,i}$ is a scalar. Finally, we assume that

$$f_{it} = \mu_{i+}\rho_i f_{it-1} + \epsilon_{it}, \quad i = 1, 2, 3.$$

This model can be estimated straightforwardly using Maximum Likelihood and the Kalman filter.

3 Data

Unlike term structures derived from financial market yields that are measured at the same time and differ only in terms of their time to maturity, the term structures of inflation expectations that we construct are based on measures of inflation expectations drawn from a range of UK sources with different characteristics, sampled at different dates within each quarter. These measures include high frequency financial market implied measures derived from inflation swaps, the quarterly forecasts of professional economists as reported in surveys of forecasters (these are the H M Treasury survey of independent forecasters and the Bank of England's survey of external forecasters), and the responses to regular quantitative inflation expectation surveys at different horizons (one-year ahead, two-years ahead and five-to-ten years ahead) of households (the Bank of England/TNS survey, the Barclays Basix survey and the Citigroup/Yougov survey) and businesses (the CBI survey).[2] Domit, Jackson and Roberts-Sklar (2015) provide further details on the surveys.

Apart from differences in the respondents, and timing, the surveys also differ in the measures of inflation that they reference. The forecasts of professional economists are referenced to inflation in the Consumer Price Index (CPI), while financial markets measures are referenced to inflation in the Retail Price Index (RPI), where RPI inflation is typically higher than CPI inflation by around one percentage point. The household and business surveys are not referenced to any specific index. For example, the Bank of England/TNS survey asks about expected changes in 'prices in the shops'. As a consequence, the levels of inflation expectations in the different series are not the same. We express them in CPI-inflation space by adjusting for the level difference between the relevant series at the shortest maturity and CPI inflation over the available sample period of each series. Our summary measure of inflation expectations will remain in CPI-inflation space in the future provided that the relationship between individual inflation measures and CPI inflation does not change.

[2]Given that most of the survey information is collected quarterly, we construct the summary measures at a quarterly frequency. We average more frequently available series across their monthly (Citigroup/Yougov survey) or end-month (inflation swaps) values.

Our approach relies on there being a relatively stable inflation expectations curve that underlies the different measures of inflation expectations that are available. For our method to be informative it has to be the case that the common factors that underlie the individual observed series are less volatile than the idiosyncratic components of those series. The next section provides evidence that suggests that this is the case.

4 Illustrative Results

Outputs from the model are shown in Charts 1 and 2. Chart 1 plots the time series of the derived summary measure for one-year ahead inflation expectations alongside all of the individual measures of one-year ahead inflation expectations expressed in CPI inflation space. The summary measure appears to capture well the broad movements in the data while ignoring noise in individual series. Chart 2 plots a time series of the derived term structure of inflation expectations at short- to medium-term horizons. These series are again expressed in CPI inflation space. The higher level of five- to ten-year ahead inflation expectations is largely a reflection of the persistently higher level of the Citi/Yougov household survey at that maturity relative its one-year ahead measure. The level of these series is best judged by comparing each series to its average value in the period when inflation appeared clearly anchored to the target (pre-2008).

While our focus is on measurement of inflation expectations, it is worth noting that using the one and two year ahead inflation expectations as a forecast of future inflation, results in forecasts that can beat a random walk benchmark. In particular, we find that, over the period 2006Q1 to 2016Q2, the relative MSE, compared to a random walk forecast, for one year ahead forecasts is 0.892, while the two year ahead one is 0.883.

5 Conclusions

In this short note we have presented a new method of summarising, and an associated summary measure of, inflation expectations. The method is an adaptation of the well known Nelson-Siegel model of the interest rate yield curve that has been extended to allow for multiple surveys of expectations at different maturities. The proposed measure seems to capture effectively the

signal contained in UK surveys and, as a result, be of use to policymakers.

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Figure 1: One-year ahead inflation expectations

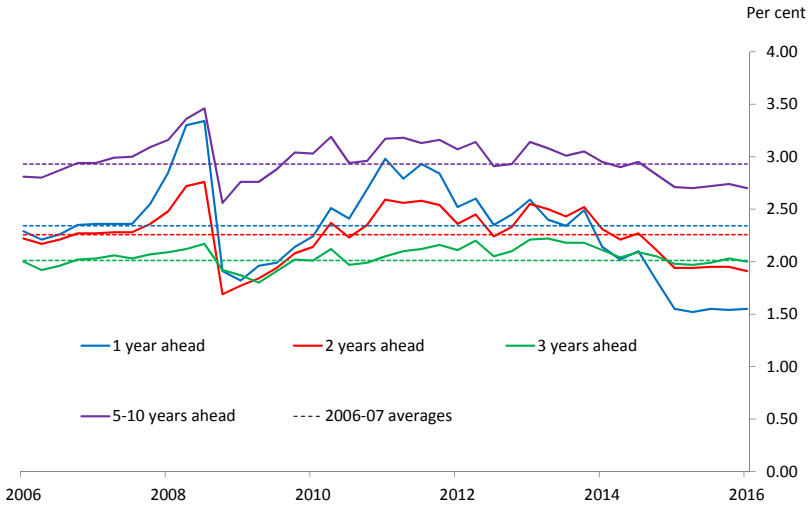

Figure 2: Term structure of inflation expectations at short- to medium-term horizons